Engineering Workstation Research Study

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# ENGINEERING WORKSTATION
# RESEARCH STUDY

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INPUT

ENGINEERING WORKSTATION
RESEARCH STUDY

CONTENTS

# 1 INTRODUCTION

# I INTRODUCTION

- This research is part of a custom market research and consulting project under-taken for Scientific Calculations, Inc. This report describes the current views and major requirements of an interactive graphics workstation for electronic process engineering functions.

## A. OBJECTIVES

- The intent of this research has been to determine:

  - The receptivity of an interactive graphics workstation for electronic process engineering functions.

  - The relative importance of electronic manufacturing engineering applications.

  - The potential buyers and their decision and selection criteria for an engineering workstation.

  - The system support and application consulting requirements.

- The key elements have been the user's view toward the functions of electronic process definition. These functions are stated as being:

  - Productivity.

  - Process routing and instruction planning.

  - N/C generation.

  - Automatic test programming.

  - Tool and fixture design.

- Drawing and artwork generation.

- Work cell design.

- Standards development.

## B. METHODOLOGY

- With participation by Scientific Calculations management personnel, INPUT prepared a list of potential interviewees and a research questionnaire.

- Telephone interviews, based on the questionnaire, included as Appendix A, were conducted by senior INPUT consultants.

- The research was intended to reflect the views of the users, as fabricators and/or assemblers of PCB's and vendors in the form of service bureaus to the users.

  - The companies interviewed as fabricators and/or assemblers were high technology companies thought to be involved with the process definition of PCB's.

  - The service bureaus were expected to come from interviews with the users.

# II RESEARCH BASE

## II RESEARCH BASE

### A. INTERVIEWS BY CATEGORY

- Thirty-four interviews were conducted with the breakdown, by category, as follows:

| CATEGORY | NUMBER | PERCENT |
|---|---|---|
| Fabrication Only | 1 | 3 |
| Fabrication & Assembly | 8 | 23 |
| Assembly Only | 20 | 57 |
| Service Bureau Users | 4 | 11 |
| Service Bureau Vendors | 2 | 6 |

- With 97% of the respondents involved with the assembly of PCB's there is a clear bias toward their requirements in this research.

- The names of companies to be interviewed as service bureaus were expected to come from the users. This did not materialize.

- None of the users reported consistent use of any service bureau for fabrication and assembly.

### B. RESPONDENT PROFILE

- With all companies, an effort was made to interview that person who was best able, by virture of position and experience, to deal with the issues of electronic process definition.

- In more than three fourths of the interviews, that person was in manufacturing engineering or manufacturing support as indicated by the following break down:

| FUNCTION | NUMBER | PERCENT |
|---|---|---|
| Manufacturing Engineering | 16 | 46 |
| Manufacturing | 4 | 11 |
| Engineering | 3 | 9 |
| Manufacturing Support | 12 | 34 |

- It is also significant that all but two interviews were conducted with managers, the exceptions being a Senior Industrial Engineer and a Project Coordinator.

- Appendix B is a complete listing, by category, of all the companies participating in the research and the title of each respondent.

## C. CAD PERSPECTIVE

- The knowledge of most of the respondents of their company's current use of CAD equipment was limited and not very positive.

- Almost ten percent of the respondents reported no use of CAD and fifteen percent did not know the vendor of the CAD equipment used.

- No one vendor was reported as having a significant share of the companies interviewed, as indicated by the following report.

| CURRENT VENDOR | PERCENT |
|---|---|
| APPLICON | 13 |
| CALMA | 13 |
| COMPUTERVISION | 13 |
| GERBER | 10 |
| RACAL REDAC | 10 |
| SCICARDS | 8 |
| HEWLETT-PACKARD | 5 |
| IBM | 5 |
| DID NOT KNOW | 15 |
| NONE | 8 |
| | 100 |

# III ELECTRONIC PROCESS DEFINITION

## III ELECTRONIC PROCESS DEFINITION

### A. RATING BY FUNCTION

- When asked to rate the stated process engineering functions, on a scale of 1 = low to 5 = high, in terms of the importance of these functions to their organization, the respondents reported in aggregate as follows:

| FUNCTION | TOTAL USERS | RANK |
|---|---|---|
| Producibility | 4.3 | 1 |
| Process Routing & Instruction Planning | 3.2 | 5 |
| N/C Generation | 2.8 | 6 |
| Automatic Test Programming | 3.5 | 4 |
| Tool & Fixture Design | 2.8 | 6 |
| Drawing & Artwork Generation | 3.7 | 3 |
| Work Cell Design | 2.7 | 8 |
| Standards Development | 3.8 | 2 |

- The only category with enough respondents to have any statistical significance at all is those companies involved only with the assembly of PCB's.

- Their response to the rating of the process engineering function is as indicated:

| FUNCTION | ASSEMBLY ONLY | RANK |
|---|---|---|
| Producibility | 4.2 | 1 |
| Process Routing & Instruction planning | 3.6 | 3 |
| N/C Generation | 2.8 | 8 |
| Automatic Test Programming | 3.4 | 5 |
| Tool & Fixture Design | 2.5 | 7 |
| Drawing & Artwork Generation | 3.5 | 4 |
| Work Cell Design | 3.0 | 6 |
| Standards Development | 3.8 | 2 |

- The difference between the two reports is not great. The two most important functions, producibility and standards development are virtually the same.

- The next three, process routing and instruction planning, automatic test programming, and drawing and artwork generation are the same but in a slightly different sequence.

- The final three, N/C generation, tool & fixture design, and work cell design are also the same but in a different order.

- The difference between the ranking of the top two-producibility and standards development-and the lowest ranking functions is significant and, as previously indicated, is consistent among all users.

## B. USER VIEWS BY FUNCTION

### 1. PRODUCIBILITY

- The concensus on the requirements is for design analysis, supported by a data base.

- The ability to interface to automatic insertion equipment was the most frequently cited requirement.

- The most frequently cited application was for standardization. Determining limiting conditions such as for space, tolerances and copper was second, and documentation and artwork to enhance producibility was also mentioned as an application.

- A representative comment was that producibility is: "Adherence to design criteria."

### 2. PROCESS ROUTING AND INSTRUCTION PLANNING

- The concensus on requirements is for word processing, graphics and text handling, from a data base with a query facility to support process flow analysis and machine loading.

- Interface to MRP II was also cited; primarily because of that particular company's investment in time, money and personnel to implement the system.

- The applications cited were, once again, primarily for standardized routing and production control.

- Comments indicating a highly sophisticated view wants, "3-D views of boards for different operating instructions," and, "Different colors for different stations and numbering." This was the only reference to 3-D or to color graphics.

3. N/C GENERATION

- The requirements as stated by a clear majority were simply for an interface to their CAD equipment (whatever it is) and an interface to their N/C machines.

4. AUTOMATIC TEST PROGRAMMING

- Again, the stated requirements were clearly for interfaces to their Automatic Test Equipment and to their CAD systems.

- There were also mentions for a high level programming language.

- The stated applications were for simulations and the development of reworks plus the preparation of a net list.

5. TOOL AND FIXTURE DESIGN

- As in N/C generation, the stated requirements are for an interface to CAD and to N/C machines.

- A composite of the applications stated is to determine the reliability and accuracy of tool and fixture data.

6. DRAWING AND ARTWORK GENERTION

- The majority of the users again cited an interface to CAD as a requirement.

- There was also a strong requirement that the user have access to the design data base.

- Finally, the users are looking for a system that is both flexible and easy to use. High resolution was stated as a need; color graphics, was not.

- Once again, the most common application cited was for standardization. Dealing with changes and current documentation also had several mentions.

- Comments suggested the desire for both printer and plotter output.

- And, one respondent went so far as to say, "This is an engineering function, not an ME function."

7. WORK CELL DESIGN

- Once again, the most frequent requirement specified was for an interface to existing CAD systems.

- The users also want to be able to easily modify the layout of the work cell.

- The stated application was for an improvement in standards and in time performance, and for operator instructions.

8. STANDARDS DEVELOPMENT

- The most common requirement was for an interface to the company's main frame computer under data processing control.

- Access by IE's was also needed to effect standardization.

- The development of standards and producibility seemed, in the view of many, to be closely linked as indicated by these comments: "Cannot have producibility without standards." and "It is the best way to implement internal standards."

- Although standards development was regarded by most as being a key issue and difficult to deal with because of its ramifications, one user disputed that by saying, "It is one of the simpler tasks to automate."

# IV PROCESS DEFINITION APPLICATIONS

# IV PROCESS DEFINITION APPLICATIONS

## A. APPLICATION REQUIREMENTS

- The concensus from all users is for a system with:

  - A high degree of flexibility, indicating that they do not even know today how they would use a system dedicated to the needs of manufacturing engineering.

  - Integration capabilities to other engineering and manufacturing systems, indicating that the management personnel of the departments will be involved with the decision and the system.

  - Networking, indicating an awareness of a current widely used term and a likely requirement from data processing. And, a data base. Most of the users understand the role that data base technology is going to play in satisfying the needs for integration and corporate acceptance.

- Ideally, a manufacturing engineering system will aid significantly in getting CAD to the shop floor. To do this, the system will have to be integrated with engineering and manufacturing applications.

## B. LANGUAGE REQUIREMENTS

- Respondents reported the use of the following language processors:

  - BASIC.

  - "C".

  - FORTRAN.

  - PASCAL.

- APT was stated as a requirement for programming N/C tools.

- Compatibility with IBM mainframe systems and military specifications was also stated as a requirement.

- No single language processor or operating system is an absolute requirement in the mind of the respondents. However, there was general agreement on the need for a flexible, high-level progamming language.

- Once again, the persistant request was for a networking capability off of a data base.

# V THE SYSTEM DECISION PROCESS

# V THE SYSTEM DECISION PROCESS

## A. DECISION RESPONSIBILITY AND INVOLVEMENT

- The majority of the respondents identified Manufacturing Engineering Management as having the responsibility to buy the system to be used for electronics process definition.

- The decision process will almost always include management in the related disciplines recognized as being an ingredient necessary to success.

- The corporate management function will almost always be involved because the implementation of a system in manufacturing engineering is viewed as impacting other installed systems, corporate data processing and other discplines related to production.

- And, as expected, the role of the committee is particularly strong in some of the companies interviewed and it was said that the committee will make the final selection. The committee may make the company easier to sell to because, hopefully, all of the involved personnel will be clearly identified.

## B. DECISION FACTORS

### 1. FEATURES

- The stated decision factors were not very specific and tended to be a restatement of many of the points made earlier in the interview. These were" interfaces and compatibility, flexibility and ease-of-use.

- Reliability of the product and reputation of the vendor were identified as being necessary ingredients.

- The factor cited as being most important was functionality. The problem of course, is that this has not been defined and, is likely to differ for each member of the buying team.

- The challenge to Scientific Calculations is to develop the product that is sufficiently flexible to be presented and viewed by the buying team as meeting or having the ability to meet their application requirements.

2. BENEFITS

- The most common expectation from the successful implementation of a process engineering system was improved productivity of the manufacturing engineering staff.

- The second benefit was increased competitiveness by being able to respond to engineering changes faster and better.

- Producibility was not mentioned as a key benefit.

## C. POSSIBLE VENDORS

- Those companies cited as being possible vendors of an electronic process definition product were: Applicon, Calma, Computervision, Hewlett-Packard, Intergraph, Prime and Scientific Calculations. No one company dominated the list.

- One respondent said that no one would be able to satisfy the requirements of manufacturing engineering.

- It is significant that few of the companies interviewed were actively looking for the system capability described. Therefore, they cannot be expected to have an educated opinion regarding possible vendors.

# VI OBSTACLES TO SALES AND IMPLEMENTATION

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## A. OBSTACLES TO IMPLEMENTATION

### 1. UNCONTROLLABLE

- There are a number of environmental factors, present in all companies, many of which are going to be obstacles to the successful sale and implementation of a system as comprehensive as one dealing with electronic process definition.

- A major factor in this category is a general resistence to change that is particularly prevalent among engineers in disciplines where there has not been much automation by computers. Manufacturing engineering is such a discipline.

- Most companies have, at one time or another, had a bad experience with computers in engineering or in manufacturing and will be particularly watchful in the new area of manufacturing engineering.

- A manufacturing engineering system will, by its very nature, be highly visible and will require the support of both engineering and manufacturing.

### 2. CONTROLLABLE

- Many of the obstacles can, to a large extent, be influenced by the vendor and need to become a part of the marketing and sales process.

- Because there is little if anything currently available to manufacturing engineering for electronic process definition, the proposed capability is unlikely to be "pulled" by the prospective users but instead will have to be "pushed" by the early vendors.

- A key factor of this "push" strategy will be the proper education of the user regarding the scope and benefits of the proposed system. No one will gain if the proposed benefits of the system cannot be accomplished within the individual company's environment.

- All of the management personnel involved in the decision and in the operation of the system will have to be educated as to its scope and benefits as it pertains to their responsibilities.

- The respondents indicated that a significant obstacle will be the integration of the proposed electronic process definition system with existing systems and data bases within engineering and manufacturing.

- Confidence in the training of the users, both operators and engineers, was also cited as a likely obstacle to success. This can be adddressed by making the training program a part of the sales strategy.

- The concept of the system, as presented by INPUT, is regarded by most of the companies interviewed as a major task that cannot be underestimated by either the vendor or the user. As such, a complete understanding of the needs and the benefits and working together will be required for success.

- Although references will be important, they will not be substitute for an individual account implementation strategy.

## B. PRICING

- Currently, pricing is seen as an obstacle only by those people interviewed with the ability or confidence to sell at a low price level, i.e., less than $25,000. These people are hoping it will be very easy, price-wise, to get a manufacturing engineerng system into their company.

- Just over one-third of the respondents viewed the system we discussed as being priced at $25,000 or less.

- One-fourth viewed the system cost at being greater than $100,000. Obviously, there is a large difference in what is thought to be required and what the proposed system will do.

- The opinion of fourty percent was for a price between $25,000 and $75,000. And, an additional ten percent did not know what the cost should be.

- The stated mean price was $60,000; the median was $50,000. The distribution was as follows:

| PRICE RANGE | PERCENT |
|---|---|
| Under $25,000 | 35 |
| $25-50,000 | 14 |
| $50-75,000 | 10 |
| $75-100,000 | 17 |
| OVER $100,000 | 24 |
| | 100 |
| DO NOT KNOW | 9 |

## C. SUPPORT REQUIREMENTS

- When the prospective user defines support requirements, he is also defining system/vendor selection requirements and purchase criteria.

### 1. TRAINING

- User training was cited by most of the respondents as being their primary support requirement.

- Sometimes this was cited because of their knowledge of insufficient training for the CAD equipment in engineering. Other times it was their awareness that the ME's have not been exposed to extensive automation.

- The majority of the respondents want user training conducted on site with an emphasis on "training the trainers" so that the company can become self sufficient in user training.

- Another training requirement is off-site but that is at a more detailed, technical level, primarily for those manufacturing support personnel who have to support the general computing needs of the users.

2. MAINTENANCE

- The respondents are looking for a single source for both hardware and software maintenance.

- The concept of a "response center" that would insure application and software support via the telephone was cited by many.

3. DOCUMENTATION

- The need for documentation at two levels was cited by many. One level would be easy to understand and use for operators; the next would be at a more detailed level and intended for application support personnel.

4. CUSTOM PROGRAMMING

- Most of the respondents felt that custom programming would be required to satisfy all of their application needs. The concensus was that they do not want the ME's to get too heavily involved with programming and not all of them have programming personnel available to them. Therefore, a custom programming capability from the vendor would be used by many of the respondents.

# VII CONCLUSIONS

# VII CONCLUSIONS

## A. RECEPTIVITY

- Because approximately one-half of those interviewed were Mangers of Manufacturing Engineering and because a system that deals with electronic process definition is not generally available, INPUT believes that the receptivity to the product currently being defined by Scientific Calculations is high.

## B. POTENTIAL BUYERS

- The most likely early buyers of the system currently being defined are going to be generally large companies who:

  - Deal with a wide variety of boards.

  - Have a large number of boards, many with high volume.

  - Have numerous engineering changes to the boards they fabricate and/or assemble.

## C. USER ME FUNCTION

- From the eight functions stated, producibility and standards were the most important.

- The next most important groups included drawing and artwork, process routing and instruction planning, and automatic test programming.

- PRODUCIBILITY is the key function with all cf the others in support of it.

## D. SYSTEM REQUIREMENTS

- In the eyes of the users, the requirements for a manufacturing engineering system for electronic process definition are based upon a data base, integrated with related systems, networking and interfaces to CAD systems, N/C machines, ATE equipment and last but not least, the data processing department's mainframe computer, probably an IBM.

- The user also wants a flexible, high level language that is also easy to use and can be used by others, including the vendor, for custom programming.

- There is currently no strong language or operating system requirement.

- The user will also require confidence in training programs, documentation and maintenance for both hardware and software.

## E. DECISION PROCESS

- The decision process will be complex because it will be integrated with other departments.

- The required functions have not yet been set in the mind of the buyer and will have to be put there by the seller.

- Productivity will be the basis upon which the system will ultimately be purchased.

# Appendix A: Research Questionnaire

USER QUESTIONNAIRE CATALOG NO. ☐☐☐☐☐☐

Good morning (afternoon). My name is _____ calling from INPUT, an international market research firm. We are currently conducting a study in the area of interfaces and computer aided manufacturing for the electronics industry, specifically process definition for the assembly of PWB's. Our research indicates that your firm operates in this area and we would like to ask you a few questions which will require only a very short time. First...

1a. In our discussion of computer aided manufacturing, will you be describing aspects of your company's total effort or, will you be limiting yourself to the activities of a particular division or operating unit?

( ) Entire organization (If checked, go to #2).
( ) Division (Name: _____)
( ) Other (Describe: _____)

1b. Whom should we contact to obtain information on the computer aided manufacturing activities of your other divisions or units? _____

_____

_____

_____

2. For the purpose of this study, we are interested in the following activities:

%
( ) PCB fabrication and assembly
( ) PCB assembly only
( ) PCB fabrication and assembly done by a service bureau
(Name: _____).

What percentage of each activity characterizes your organization?

3. We would like to continue by asking you which of the computer aided design systems you currently have installed for PCB design. (Multiple okay)

a. ( ) Applicon
b. ( ) CADAM
c. ( ) Calma
d. ( ) Computervision
e. ( ) Racal Redac
f. ( ) Scicards
g. ( ) Other Name: _____
h. ( ) None

CATALOG NO. ☐☐☐☐☐☐

4a. Thank you, for the purpose of this study, we are focusing on computer aided electronic process definition which we define as consisting of:

| FUNCTION | RATING (1-5) | MOST IMPORTANT AUTOMATION CONSIDERATION |
|---|---|---|
| 1. producibility | _____ | _____ |
| 2. process routing and instruction planning | _____ | _____ |
| 3. N/C generation | _____ | _____ |
| 4. automatic test programming | _____ | _____ |
| 5. tool and fixture design | _____ | _____ |
| 6. drawing and artwork generation | _____ | _____ |
| 7. work cell design or work station layout | _____ | _____ |
| 8. standards development | _____ | _____ |

4b. On a scale of 1 = low to 5 = high, would you please rate these functions in terms of their importance to your organization. (Go to question #4a.)

4c. (Interviewer, if not clear, ask:) What are the 2 or 3 most important functions? (Note with an * on question #4a).

4d. Within each function, what do you consider to be the most important automation consideration? (Go to question #4a).

5a. Continuing on from the functions as I have listed them and the key considerations for automation that you have indicated, what are the specific applications that you would want to have tailored to your manufacturing operation? _____

5b. If provided with a high level programming language, which of these applications would you want the manufacturing engineer to enhance or customize? _____

5c. Thank you, are there any specific languages or operating systems that you require? _____

6. What would you expect from the vendor of this system in terms of education, training, support, etc.? _____

7a. Who would have the responsibility to purchase this manufacturing engineering workstation, as described, within your organization? _____

7b. Who else would be involved in the decision/buying process? _____

CATALOG NO. [ ][ ][ ][ ][ ][ ]

8. What do you believe would be the primary decision factors in buying this proposed workstation? _____

_____

_____

_____

9. What do you see as being the obstacles to implementing such a system?

_____

_____

_____

10. How many users in the manufacturing department would you want to provide with these canned tools? _____

_____

_____

11. Of the vendors in this marketplace that you know, whom do you believe has or will have such a system? When? _____

_____

_____

_____

12. Finally, given what you know about this proposed workstation, what is your opinion as to how it would likely be priced? _____

_____

a. ( ) under $25,000
b. ( ) $25 - 50,000
c. ( ) 50 - 75,000
d. ( ) 75 - 100,000
e. ( ) over $100,000

13. Thank you, that completes our interview. We appreciate your cooperation. If we have any further brief questions, may I call again? Yes _____ No _____

14. As a thank you for your participation, I will send you a summary of the research upon its completion. Let me confirm the mailing address.

_____

_____

# Appendix B: Interviews By Category

APPENDIX B

INTERVIEWS BY CATEGORY

## FABRICATION ONLY

| | |
|---|---|
| BEEHIVE INTERNATIONAL | MGR. ENGINEERING |

## FABRICATION AND ASSEMBLY

| | |
|---|---|
| AUGAT | MGR. ENGINEERING SERVICES |
| COMPUTER CONSOLES | MGR. MFG. ENGINEERING |
| GENERAL MOTORS | |
| DELCO ELECTRONICS DIV. | MGR. MFG. ENGINEERING |
| HEWLETT-PACKARD | |
| DATA TERMINALS DIVISION (HIGH VOLUME) | MGR. MFG. ENGINEERING |
| DISC MEMORY DIVISION | MGR. ENGINEERING |
| JOHN FLUKE MANUFACTURING | MGR. PRODUCTION |
| TEXAS INSTRUMENTS | MGR. AUTOMATION<br>MGR. CAM |

## ASSEMBLY ONLY

| | |
|---|---|
| ACME ELECTRIC | MGR. MFG. ENGINEERING |
| ADAGE INC. | MGR. MFG. ENGINEERING |
| ALLEN BRADLEY | MGR. ASSEMBLY |
| AMDAHL | MGR. MFG. ENGINEERING |
| AM INTERNATIONAL | SN. INDUSTRIAL ENGINEER |
| ANDERSON JACOBSON | MGR. TEST ENGINEERING |
| BAIRD CORP. | MGR. MFG. ENGINEERING |
| BENDIX | |
| AVIONICS DIVISION | MGR. PROJECT ENGINEERING |
| COMMUNICATIONS DIV. | MGR. MFG. ENGINEERING |
| BOWMAR INSTRUMENTS | MGR. PRODUCTION ENG. |
| CONRAC | MGR. MFG. ENGINEERING |
| HARTMAN ELECTRIC | MGR. MFG. ENGINEERING |
| HEWLETT-PACKARD | |
| DESKTOP COMPUTER DIV. | MGR. ENGINEERING |
| SCIENTIFIC INSTRUMENTS DIV. | MGR. MANUFACTURING |
| HONEYWELL | MGR. PURCHASING |

| | |
|---|---|
| NCR | GENERAL MANAGER |
| RAYTHEON | |
| ELECTRO-MAGNETIC SYSTEMS DIV. | PROJECT MANAGER |
| RCA | |
| ELECTRO-OPTICS & DEVICES DIV. | MGR. MFG. ENGINEERING |
| WANG | MGR. TECHNOLOGY |
| WESTINGHOUSE | |
| ELECTRICAL SYSTEMS DIV. | MGR. MFG. ENGINEERING |

**FABRICATION & ASSEMBLY BY SERVICE BUREAU**

| | |
|---|---|
| COLECO | MGR. MFG. ENGINEERING |
| CUBIC CORP. | MGR. MFG. ENGINEERING |
| HEWLETT-PACKARD | |
| DATA TERMINALS DIV. (LOW VOLUME) | MGR. MFG. ENGINEERING |
| KEARNEY & TRECKER | PROJECT COORDINATOR |

**SERVICE BUREAU**

| | |
|---|---|
| DAK INDUSTRIES | MGR. MARKETING |
| | MGR. PRODUCTION |